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ABSTRACT

Educators, concerned over the educational deficiencies of many students, largely from low-income and minority populations, are seeking new instructional techniques. One method which may hold considerable promise for remedial education is computer-assisted instruction (CAI). The present paper describes CAI, its various uses, its particular adaptability to the needs of new students, and the problems which hinder its widespread adoption at the present time. In addition, the results are presented of a survey of six installations which are using CAI in remedial programs for college students. Included in the survey are descriptions of the facilities of each installation, their operational procedures, educational materials, and evaluative data. Recommendations are offered to future CAI installations based upon these observations. Finally, an annotated bibliography is included which describes the current major references available on CAI and the new student. (Author)

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COMPUTER-ASSISTED INSTRUCTION AND THE NEW STUDENT

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INTRODUCTION

This paper reports on one element in Program 10--Developing Relevant Programs for New Students--a study being carried out at the Center for Research and Development in Higher Education.

In describing the "new" student, Cross (1971) has predicted that by the end of this decade one-third of the students pursuing postsecondary education will be drawn from low achieving, economically disadvantaged segments of the society, those in which ethnic minorities are overrepresented. It is likely that these students will be the first college-going generation in their families. Their performance in traditional secondary school academic activities will have been relatively poor, and for these students the strange new surroundings of college conspire with the experience of failure to produce an oppressive sense of threat and apprehension. To deal with these counter-productive feelings which contribute to the excessively high dropout (some say "push-out") rates of this group of students, a number of compensatory strategies have been introduced. One such technique calls for the utilization of Computer-Assisted Instruction --CAI.

The advocates of CAI contend that this educational method is uniquely adapted to the needs of the new student because of its responsiveness, its reinforcing qualities, its individuality, its tireless patience, and its neutrality. The computer guides and sustains the learning process without imposing its own feelings or biases on the learner, thus providing him with a situation free of threat or recrimination.

The present study is divided into two major parts: The first part is a general discussion of Computer-Assisted Instruction, covering what it is, reasons for its use, the process by which it assists instruction, the process and the new student, computer-assisted counseling of the new student, and the obstacles to the implementation of CAI. The second part presents the results of a survey of a number of installations which deliver educational materials to new students by means of computers. It discusses facilities, operational procedures, materials, evaluative data, and gives recommendations growing out of the findings.

As an aid to individuals or institutions considering the introduction of computer-assisted educational programs, the report concludes with an annotated bibliography of some of the major references available on the subject.

Before turning to the main body of the report, we want to express our appreciation to the institutions and program directors whose names are listed in Appendix A and whose assistance and cooperation made the survey possible. In addition, a number of other individuals aided

materially through their interest, their suggestions, and their help. These include: M. I. Charles Woodson, University of California, Berkeley; Victor C. Bunderson, University of Texas; Peter Dean, IBM Corporation, San Jose; Carolyn Stauffer, Stanford University; and Helen Lekan, AEDS. While acknowledging our debt to these generous and helpful individuals, we accept full responsibility for whatever shortcomings and limitations the report manifests.

Finally, we express our gratitude to the Office of Education; Leland L. Medsker, Director, and Lyman A. Glenny, Associate Director of the Center for Research and Development in Higher Education; and Harriet Renaud, Editor of the final manuscript--all of whom made the research possible and contributed importantly to the preparation, the format, and the style which the final version has assumed.

PART I

CAI AND THE NEW STUDENT

WHAT IS COMPUTER-ASSISTED INSTRUCTION (CAI)?

"The modern stored-program electronic computer has made more of an impact upon human activities than any other item of capital goods produced by man . . . . The influence of computers has already been felt by almost every institution and individual in society [Robinson, 1970, p.7]." As computers have profoundly altered the techniques of science and revolutionized business practices, so they have affected the potentials of education: They offer to education a means "toward satisfying the cardinal imperative of all teaching--getting to know and meet the needs of the individual child [Margolin and Misch, 1970, p.63]."

Stolurow (1969) describes two significant capabilities of the computer which make it adaptive to the educational process: It can store vast amounts of information, and it can retrieve that information virtually instantaneously on a logical basis. When these features are brought together to form an interactive system allowing direct communication between student and instructional material, the

system is called computer-assisted instruction, or CAI (Carter and Walker, 1969). In this context, interactive simply means that the computer, through its memory and its program, reacts directly and discriminatively to the responses or queries transmitted to it by the learner.

WHY USE CAI?

CAI has significant benefits to offer all sectors of the educational community: the student, the teacher, the curriculum designer, and the educational researcher.

Advantages to the Student

For the student, "the main advantage of the CAI system is the degree to which it permits the individualization of instruction [Stolurow, 1969, p.292]." Mitzel (1970) defines the general goal of a free society as genuine adaptive education, the tailoring of subject-matter presentations to fit the special requirements of each learner as an individual. "The ideal is that no learner should stop short of his full potential to grasp a subject because of any idiosyncratic difficulties he may have in learning style, or in sensory receptivity, or in personality organization [p.23]." Mitzel concludes that, due to the nature and extent of human variability, adaptive education is almost totally dependent on the individualization of instruction.

Hansen (1970), in describing the current revolution in education, also discusses the importance of individualizing instruction, and expands on the theme that learning is an individual rather than

a group experience, and that education is being asked to develop the resources and the flexibility to respond to the needs of the individual. Hall (1971) asserts that computer-assisted instruction has the flexibility and capacity for individualizing instruction.

According to Glaser (1969), individualized instruction places the burden of initiating and maintaining learning upon the learner, whereas in the traditional educational situation, this burden is placed upon the teacher. Individualized instruction nurtures independent learning, which in turn has the potential for producing individuals who are resourceful and self-appraising. The individual moves at his own rate and receives the information according to his particular capacities. This avoids the frustrations encountered by both quick and slow students in the traditional classroom. Students quick to learn certain materials may advance rapidly and go on to new materials or activities while the slower students are given enough time to master a given concept before moving on to the next topic.

Another possible advantage of CAI to the student concerns the removal of negative affect often attached to instruction in the classroom. In clarifying this point, Seltzer (1971) quotes Singer:

> The [instructional] program has infinite patience. . . . Mistakes are not penalized by scorn and sarcasm; successes are marked by positive reinforcement of "correct" student response [p.374].

Advantages to the Teacher

CAI also offers the teacher the freedom to teach more creative and stimulating materials (Seltzer, 1971). With the computer program

imparting the factual information, the teacher can focus on concepts, analyses, relationships, etc. The idea is for the computer to assume the instruction in those areas in which it is capable of enhancing the instructional process, and the teacher can minister to students individually in a manner that has never before been feasible. Thus, the computer is viewed, not as a replacement of the teacher, but as an assistant offering him emancipation from mundane chores.

Curriculum designers and educational researchers benefit from the use of CAI because it enables them to do research on various modes of teaching under more controlled conditions, collect detailed records of student performance that permit evaluation of the effectiveness of the teaching procedures and the materials, and develop ways of assisting teachers and authors in the development of instructional materials (Stolurow, 1969). CAI therefore makes it possible to individualize the instructional process, free the teacher from tedious chores, conduct research on instructional strategies, and develop more effective research.

USES OF CAI

The uses of the computer in the instructional process have been variously classified (Seltzer, 1971; Muller, 1970; Carter and Walker, 1969). The computer may be used for problem-solving, drill and practice, tutorial dialogue, simulation, information retrieval, testing, and guidance and counseling.

Problem-solving

"The incredible speed, accuracy,and tirelessness of the computer make it ideal for complex calculations which, in some cases, could not be carried off by a man in his lifetime using traditional methods . . . . The computer's ability to quickly display graphically complex situations and to modify or extend these graphical situations in real-time is the computer's uniqueness in this mode of instruction [Seltzer, 1971, p.375]."

Drill and Practice

The computer can also be used for drill and practice in conjunction with classroom instruction. Methods and concepts are taught by a classroom teacher or tutor, and the student is given the opportunity to develop skill in their application. The program monitors the student's progress by keeping track of the number of right and wrong responses he makes, and he is then advanced or sent back to appropriate parts of the program either by the program itself or by the teacher. Ideally, he is always working on portions of the material which are appropriate to his current needs.

Remedial Education

The particular adaptability of CAI drill and practice to remedial education is evident since a student may spend as much time as necessary on any given concept to attain mastery without interfering with the progress of the rest of the class.

Tutorial

When the computer is used in the tutorial mode, the student "converses" with the computer program. The presentation of instructional material presumably is based upon the student's previous experience and responses. Of the tutorial mode of instruction, Mitzel (1970) remarks that the computer may provide many functions that are characteristic of the best human tutor. Included are such services as feedback, evaluation, and recording of performance.

Simulation

Simulation is advantageous, Seltzer (1971) writes, since the real world may not be amenable to experimentation. Experiments on the real world situation may be too costly, complex, or time-consuming, whereas simulation may limit some of the variables so much that a much smaller range of experimentation is necessary. In computer simulations such as laboratory experiments and business games, the student is permitted to react to a situation, ask questions, and make decisions on which he is given immediate feedback (Carter and Walker, 1969). "The advantage of computer simulation is that it enables students to make many more measurements and handle many more complex problems [Muller, 1970, p.81]."

Information Retrieval

The "data base" capability of the computer is utilized, and files are organized so that any information relating to a given topic is immediately accessible. It is thus possible to give various

specifications to the computer program which then supplies the information to meet the given criteria. For instance, a teacher may request a biology exam from a data bank of questions. She would specify the number of items desired, the approximate content (e.g., cell division, or a biological classification scheme in Phumum Mammalia), the level of difficulty, and other dimensions by which the items were coded. Information retrieval is being used by the Xerox Corporation to reduce some 196,000 doctoral theses to computer form so that they may be retrieved by dial access (Muller, 1970). "The computer as an information retrieval system certainly has no equal, not even libraries [Seltzer, 1971, p.395]."

Testing

The computer is particularly adaptable to testing--psychological, as well as instructional. Diagnostic tests are used to determine the point of entry into the instructional sequence. Following the instruction, the student might take a posttest to assure that mastery of the behavioral objectives had been attained. Students are generally given immediate feedback on their responses, which can be highly instructional in itself, and the teacher may request progress reports for each student, enabling her to make more accurate assignments based on an assessment of student strengths and weaknesses. Cumulative records may also be kept on each item of a test, providing a ready item analysis to determine "good" and "bad" items for test construction.

Guidance and Counseling

Many of the aforementioned instructional strategies may be brought into play when the computer is used to aid in guidance and counseling. Testing, dialogue, and information retrieval are an integral part of a computer counseling program. The computer's ability to store occupational information [such as job duties, training requirements, recommended courses, working conditions, and beginning salary range (Wightman, 1970)] along with information about postsecondary education (such as entrance requirements, tuition, and scholarships), and to combine and recall them on a logical basis, makes it well-suited to aid in a student's choice of career or college or university. It is possible to use the computer to simulate an occupational situation. The student assumes an occupational role in which he may learn the characteristics of the job in order to determine his aptitude and interest in the position.

HOW COMPUTERS ASSIST IN INSTRUCTION, COUNSELING, AND LEARNING

Because of the nature of computers and programming, the use of CAI requires systematic thinking on the part of those involved in its implementation. Hansen (1970) describes this requirement as one of the most fundamental ways in which the computer can aid in the process of instruction. He remarks, "I have yet to see the computer introduced into some phase of the educational process . . . but that it has not forced the people involved to begin to think more exactly about what tney are doing and why they are doing it [p.197]."

The use of the computer in developing CAI materials makes it necessary to define educational goals and strategies, and this should strengthen the instructional process. The curriculum is thus developed with specific goals in mind, and the curriculum specialist is able to revise the materials by means of the feedback from student performance recordings, eliminating the "dead weight," and refining the path or paths leading to the objectives.

The systematic thinking involved in program construction and the subsequent program refinement based on student performance combine to create learning materials adaptive to student needs. The environment in which the student learns consists of programmed materials displayed on a terminal which may differ in its capabilities, but in general consists of a typewriter, or teletype, which is controlled by the computer program. In a typical CAI session, the student seats himself before a terminal and keys in some identifying characters which the computer program recognizes as belonging to this student. The computer locates the student's file and begins the lesson where the student had signed off previously. He is then presented instructional material with which he interacts and, on the basis of his response, is given immediate feedback--told to advance, given assistance, or told to try again.

The dynamic interchange between the student and the instructional system is one of the advantages of the CAI system over other modes of instruction (Stolurow, 1969). Mitzel (1970) compares the conventional classroom with the CAI laboratory. In the case of the

traditional school, questions are asked of an entire class, with the more aggressive students responding on the average of about five times per class period. The shy, noncompetitive child may recite once a week or once a month, and the feedback he receives may be hostile or negative, thus solidifying his fears of classroom participation. In the typical classroom at a college or university, the picture is even more dismal, with single classrooms often accommodating a hundred students or more. CAI serves to alleviate many of these difficulties; each student working at a terminal may receive feedback as many as 40 times during a 20-minute interval.

CAI and the New Student

Educators are seeking new methods for dealing with the educational deficiencies of low-achieving low-income populations from childhood through adulthood. The problems created by traditional classrooms are described by Mitzel (1970), who points out that there is insufficient human warmth and opportunity for experiencing success in the typical classroom, "and this lack of a mentally healthy environment is most prevalent in inner-city schools where there is a clash of middle class teacher values and lower class pupil values." A further indictment of the schools in dealing with the poor and foreign-speaking is made by Martin (1971): "From 50 to 70 percent of the children from such families are unable to read or compute effectively after six, eight, and twelve years of schooling [p.16]."

In recent years, efforts have increased to recruit economically

disadvantaged students and enroll them in higher education (Astin, 1970). One example of such endeavors is the publication of *A Chance to Go to College*, prepared by the College Entrance Examination Board, which is sent to all high schools in the United States. A directory of over 800 colleges and universities which have special programs to help students from minority and low income families, it includes general information about how to apply for admission and financial aid, and brief descriptions specific to each college about eligibility, criteria for admission, aids to students, application fee, closing date for admission, and the name and address of the person in charge of special programs.

The Educational Opportunity Programs in the system of California State Colleges illustrates another attempt to increase enrollment of minority and low income students. Through supportive services, such as financial aid and peer counseling and tutoring, the EOP is striving to transform an educational system characterized by elitism to one of universal access (Kitano and Miller, 1970). And accompanying the induction of these "new" students is the need for special programs to compensate for their academic deficiencies. Margolin and Misch (1970) have described ways in which computer-assisted individualized instruction can be particularly valuable for rem dial education: through lessened pressures, individualized programs, an unusual degree of isolation from distraction, close and detailed attention to progress, wide and rapid variation of stimulus input, and extraordinary patience. In addition, as Seltzer (1971) quotes

Singer: "The [instructional] program . . . does not have preconceived notions about a student . . . it removes a certain amount of human contact which for some ghetto students is continually frustrating and abrasive [p.374]."

Louis Bright, Assistant Commissioner for Research for the United States Office of Education, remarks about his observation of the positive effects of CAI on students from disadvantaged backgrounds: "At the beginning, these students were generally antisocial--either extremely withdrawn or hostile--but one could observe definite changes within six weeks, and within three months they became self-confident extroverts. The change can probably be attributed to the fact that they were being consistently successful for the first time in their lives, instead of being continually punished by failure [Margolin and Misch, 1970, p.xi]."

The socializing role of CAI was the object of a study by Hess, et al. (1970). Subjects for the study included 189 junior high students from lower SES backgrounds, 50 of whom were engaged in remedial math instruction via CAI. Comparisons were made on attitudes toward computers between the 50 students receiving CAI (the CAI group) and the 139 students receiving conventional instruction. The outcomes indicated that both groups viewed the computer as a more reliable source of information than other sources, and that the CAI group tended to place greater trust in learning situations monitored by the computer. The CAI group also expressed a more realistic appraisal of the "fallibility" of computers. The greater confidence in the computer than the teacher

was attributed to more objective evaluation received from the computer. Teachers were viewed as being influenced by variables other than those pertaining to subject matter knowledge.

In describing 41 projects which are seeking materials and instructional systems to accelerate and enhance the learning process for our 56 million undereducated adults, Sherron (1971), involved with the program titled Adult Basic Education (ABE), names CAI as one of the techniques which offers numerous possibilities for avoiding or overcoming the inadequacies of traditional instruction.

Computer-Assisted Counseling and the New Student

Urban schools are faced with increased numbers of student enrollments without a proportional increase in counselors to help the students make appropriate course and career decisions (Margolin and Misch, 1970). The computer should prove an invaluable aid in coping with the massive volume of record-keeping involved in today's educational and occupational counseling.

At a conference held at Harvard to acquaint counselors, directors, coordinators, and administrators with several computer guidance systems, the general consensus was that computers will contribute to the guidance function and will have implications for the training and role of the counselor. Among the issues raised were the general relevance of counseling programs, especially for the economically disadvantaged populations; the possibly depersonalizing effect of the computer; and counselors' fears of being replaced (Baruch, 1969).

Since the counseling profession is particularly involved with humanistic values, allegedly dehumanizing properties of the computer-aided counseling process is critical. The conferees' initial concern over this question was greatly alleviated as they learned about and used the systems; rather, the comment was made that the computer, by assuming the duties of "paper-shuffling" and "busy work," could force counselors to counsel. The computer, an extension of man's imagination, was seen as empowering rather than dehumanizing.

Although there are those who feel that the computer may threaten to replace the counselor, there are instances in which the use of the computer as counselor may be especially advantageous. One of the Harvard conference participants argued "that a neutral computer, free of the biases and pressures to which counselors are usually prey, can elicit a kind of trust and honesty from the user that few counselors can bring forth. With the absence of counselor "set" and expectation, ". . . a son of an unskilled worker could dare to dream and explore some course of further action involving leaping across the vast socioeconomic gulf that separates classes in the United States [Baruch, 1969, p.21]."

In the same vein, Holtzman (1970) has remarked that, 'In some situations a patient, friendly, responsive and amoral computer program --even though offered only as a mechanical aid--may help develop favorable attitudes in students who are unable to relate to their regular counselors. For example, numerous school systems will face for some time the problem of white counselors, many of whom are unable

to serve adequately the guidance needs of black youths [p.382]."

Two cases which support the above comments can be found in the advice given to Malcolm X (1966) and a female Chicano student (Kitano and Miller, 1970). Both reported themselves as excelling their fellow white students academically, but were discouraged from their expressed desire to attend college. Malcolm X was advised to become a carpenter, the Chicano student to attend beauty school. It is of the essence that such inequities cease, and computerized counseling may move us toward this egalitarian goal.

OBSTACLES TO THE IMPLEMENTATION OF CAI

Why has CAI not been embraced by the educational community? The answer is that it is expensive, there are insufficient personnel with adequate skills, and there is a scarcity of "good" instructional material.

The Costs

New York public education costs range from 33 cents to $3.00 per pupil hour (Hall, 1971), whereas the initial costs of CAI systems ran as high as $35 to $40 per pupil hour. Today a fully operational computer instructional system costs about $3.00 per pupil hour to operate, although there is general agreement among educational technologists that this cost will decline over the next few years (Hall, 1971; Jamison, et al., 1970; Atkinson and Wilson, 1969). There are areas, however, in which the use of CAI with existing costs may be justified--such as in higher education (Seltzer, 1971) and special education (Hall, 1971). According to Hall, who reported costs as

ranging from $3.00 to $.27 per pupil hour, "Three dollars per student-hour may seem high, but it is not as high as the cost of specialized instruction such as remedial education, vocational education, or homebound education. Nor is it high if the social costs of allowing individuals to remain uneducated are considered [p.630]." Hall also made the point that full utilization of a CAI system is one means of making it economically feasible. The system could be used for daytime instruction, for evening adult education, and for administrative purposes from midnight to 8 a.m.

Grayson (1971) has reported that federal support for CAI projects has declined steadily for the past three years. During this period the amount of funds and the number of operating programs has fallen off. The reasons for this drop appear to be associated with the economic hard times which have overtaken higher education (Cheit, 1971).

As funds become less readily available, the inclination is to devote them to meeting the direct personnel costs of instruction, and only short-term support tends to be given to projects with a high start-up cost or which do not show immediate results. Brief term support is inimical to CAI operations, however, because they require a relatively long time to get under way and need several years of operation, both to refine and de-bug the system, and to permit the collection and appraisal of evaluative data.

It is unfortunate that many of the strengths (e.g., individualized instruction, flexible course structuring, self-pacing) associated

with CAI are never, in fact, incorporated into instructional programs. Thus, individuals new to CAI are likely to be impressed when they observe a system in operation regardless of the quality of the material they see. The initial reaction to a machine that "talks" to a person, calls him by name, and seems to respond to him personally, is often one of awe. People are not generally accustomed to getting personal attention either from machines or education, and it is little wonder that one's first contact with CAI usually produces enthusiasm resembling that found in new religious converts. However, this zeal fades rapidly unless the material is skillfully prepared to stimulate and maintain interest as well as impart knowledge. Because such skill is gained only with experience and thorough knowledge of program capabilities and instructional strategies, many of the decisions crucial to a CAI project ought to be deferred until after some months of intensive exploration of computer equipment, programming language, survey of existing materials, and instructional strategies. This planning and preparation period should be routinely allocated, since investigation can reveal the existence of instructional materials which meet projects' particular needs. Many software development costs could thus be avoided, and the type of computer needed clarified.

Scarcity of Instructional Materials

Perhaps the most serious drawback to the use of computers in education is associated with the dearth of instructional materials of high quality. There is as yet little operational experience in

how best to prepare an individualized curriculum (Suppes, 1969). "Despite expected improvements in instructional design and development systems and techniques, CAI course development will remain costly and time-consuming (Bunderson, 1970)."

Thus, program development should be undertaken by individuals, competent in the subject areas, who have had approximately one year of experience in writing instructional programs. As would be readily acknowledged by anyone who has attempted instructional programming, first efforts are generally primitive and unimaginative. Instructional programming is comparable to learning a new language. First, the basic commands are used exclusively. Comprehension of the nuances of the programming language and its immense capabilities come gradually with immersion in the programming language and instructional techniques. It takes time to learn to speak any foreign language fluently.

Because this factor of necessary elapsed time is not taken into account, it is common to find that as soon as funding is obtained, new personnel are hired, and decisions are made about computer and terminals. But a frantic search then ensues for instructional materials, which are only then found to be inadequate or inappropriate to the needs of the project, or written in a programming language which is incompatible with the computer system available to the project.

Unless a planning period of some duration is built in, most projects, funded as they are on a year-to-year basis, only have a few months to complete the preparation described above before school begins and students take their places before the terminals. If the project

must produce its own materials, the task becomes prodigious. Because classes must be held, first attempts are usually used as course material, and because of the necessity for producing enough material to engage the students during a quarter or semester, with no time to develop more creative and adaptive instructional strategies, the same programming techniques are used repeatedly. The picture is grim for CAI projects which produce their own curricula in a matter of a few months.

The project that can use existing programs does not labor under the frantic necessity to produce course material, but expertise is needed to recognize which extant programs meet the specific needs of the project. Project personnel new to CAI, and often lacking a strong background in education, may not know at the outset what constitutes effective instructional material. But, again, because the quarter or semester is about to begin, projects are compelled to take whatever material is available.

The analysis to this point does not, of course, refer to the institutions or instructional material which will be discussed in the second half of this report. The above discussion is an attempt to explain why many CAI projects show unfavorable results and are cancelled after their one- or two-year "probationary" period.

PART II

CAI IN REMEDIAL TRAINING FOR NEW STUDENTS

This part of the report summarizes the results of a survey of a number of collegiate institutions which are employing CAI as a means of offering remedial training to new students. Most of the programs have been in existence for a short period of time, so that the assessments are "soft" and rely heavily on subjective impressions of personnel involved with the programs. More rigorous appraisals of the growth achieved by students involved in these programs are urgently needed, as are more systematic surveys of the attitudes of students toward this mode of instruction.

SURVEY OF INSTALLATIONS

A search was made to find institutions of higher education with remedial CAI projects for students with academic deficiencies. The literature was canvassed and a review conducted of the computer users' list of the Association for the Development of Instructional Systems (ADIS). The search revealed that Bernard Baruch College of the CUNY was specifically involved with the remedial education of new students via CAI. Communication with Bernard Baruch led to other institutions

conducting similar projects. Direct personal contact was made with each of these schools to ascertain the nature of their projects, and to determine whether they knew of other institutions similarly involved.

A questionnaire (Appendix B) was sent to each of these institutions and visits were made to the campuses of Golden West College (Huntington Beach, California), Stanford University, and UCLA, to examine their installations and determine whether they qualified for the present survey. As few Golden West students would be classified as educationally or economically disadvantaged, it was decided that it could not be properly considered as dealing with new students. Golden West experiences are noteworthy, however, and will in large part be incorporated in this discussion. Although Stanford is not currently conducting remedial education on its own campus, the materials prepared there are being used by two of the schools involved in this discussion (Bernard Baruch and UCLA), and it was thus deemed desirable to have "hands on" experience with these materials. At the time of the visit, UCLA was setting up its installation in preparation for incoming students, and it is included in our study.

The following, we believe, is a complete list of colleges and universities known to be conducting remedial programs by computer for the new student:

Bernard Baruch College of City University of New York

Brooklyn College of City University of New York

Central State University, Wilberforce, Ohio

Rhode Island Junior College, Providence, Rhode Island

University of California at Los Angeles

The names and addresses of the project directors are presented in Appendix A.

The descriptive summary below of the five projects concerned with remedial education, as well as that at Golden West College, is given to provide information gleaned from the questionnaire which may be useful to institutions using or planning to initiate CAI projects.

COMPUTER FACILITIES

The computer facilities of each installation are summarized in Table 1. IBM equipment is used and located on four campuses; G.E. and PDP equipment are used at Central State and UCLA, respectively, and are remotely located. The number of terminals engaged at the five campuses under consideration ranges from nine to 20; Golden West College has 100 terminals. In general, the terminals are located in a single room divided into study carrels. However, at Central State each of the 10 terminals is located in a separate room, and at UCLA and Brooklyn College the terminals are in one room with no separations. Golden West has distributed its terminals throughout the whole community college district and uses study carrels as well as single rooms without separations, depending on location.

OPERATIONAL PROCEDURES

Four of the projects were initiated in 1971 and two (Golden West and Brooklyn College) in 1969 (Table 2). In three cases the

Table 1

CAI Facilities

	Bernard Baruch	Brooklyn	Central State	Rhode Island	UCLA	Golden West
Computer model	IBM 360-40	IBM 1500	GE Datanet 400	IBM 360/25 360/40	PDP-10	IBM 360/50
Number of terminals	15	20	10	12	9	100
Method of separation	one room/ study carrels	one room	separate rooms	one room/ study carrels	one room	one room/ with and without study carrels

Table 2

Operational Procedures

	Bernard Baruch	Brooklyn	Central State	Rhode Island	UCLA	Golden West
Commencement date	2-1-71	1969	10-1-71	7-1-71	10-1-71	1969
Termination date	indefinite	indefinite	5-31-72	1-72	9-30-72	indefinite
Proctors available during full capacity	1	0	2	1	2	1
Students per quarter or semester	150	30	100 & 200	150	100	4000
Average no. enrolled at any given time	15	30	100 & 200	60	100	4000
Attendance required	Yes	Yes	Yes	No	Yes	Yes
Free access to terminals	No	not indicated	Yes	Yes	Yes	Yes

projected termination dates are in 1972, but each of these schools hopes to expand and extend the scope of its project: Central State plans to enlarge its program to include all freshman students, UCLA to write its own course material and use on-campus computer facilities, and Rhode Island to work with local school communities in utilizing its CAI facilities. Golden West, without a projected termination date, is in the process of integrating CAI into the total college curriculum.

The number of students accommodated by the projects varies, but in general is 100 to 150 students per quarter or semester. Attendance is required of CAI students at all institutions except Rhode Island, where it is voluntary, and UCLA where 25 of the 100 students attend on a voluntary basis. Terminal time is scheduled at all schools except Golden West, which operates CAI seven days a week from 7 a.m. to 2 a.m., and UCLA, which provides CAI five days a week from 8 a.m. to 8 p.m. Aside from Bernard Baruch, the institutions allow students free access to terminals on a voluntary basis during available operating hours.

Because much of the descriptive data on CAI students could not be gathered, only the method(s) by which students were selected for CAI course enrollment will be considered. Placement exams (American College Test) were used to select CAI students at Bernard Baruch, Central State, and Rhode Island. Bernard Baruch, which offers CAI in English only, used a placement exam and faculty referral as bases for student selection. Criteria for selection at Central State, exclusively concerned with CAI in math, included ACT scores, evidence of disadvantaged financial and academic status, and high school class rank. Rhode Island

used scores on the ACT and their own pretests to select students for CAI in math and English. UCLA selected one-third of the students from the remedial math class at random to comprise its CAI sample in math (92 students); eight students were referred by the UCLA faculty for CAI in English.

INSTRUCTIONAL MATERIALS

Course materials (Table 3) have been written in Coursewriter II and Coursewriter III, Fortran IV, BASIC, and APL. This diversity of languages indicates one of the nagging problems in CAI--the high degree of specificity of programs to institutions and their unique problems. Four schools have developed their own materials and two are using those developed elsewhere.

The materials used at Bernard Baruch have been supplied by the Computer Curriculum Corporation and deal with the grammar and usage of standard, written English. UCLA, using the computer on the Stanford University campus, is using remedial math and English programs developed at Stanford. Included are drills in remedial arithmetic which progress through "grade" levels (not necessarily correspondent with school grades), 28 hours of tutorial instruction in algebra, two courses in programming of 50 and 60 hours in length, and courses in logic and English.

The Language Curriculum Development Group at Brooklyn College has developed materials to teach writing in Standard English. Materials used at Central State were written by the CAI Coordinator and the Lab Assistant. The segments, written in the drill and practice mode,

consist of eight half-hour lessons in integer arithmetic, eight half-hour lessons in decimal arithmetic, four half-hour lessons in common fractions, and one half-hour lesson each in solving linear equations and solving percent equations.

The remedial program at Rhode Island written by faculty members deals with subjects in math, English, and the development of study skills. The materials written by the faculty at Golden West deal with topics in English, general math, Spanish, biology, chemistry, physics, calculus, nursing, political science, economics, and business law.

SOME EVALUATIONS

Three projects reported evaluation procedures. Central State will use scores and class grades, and UCLA will use exam scores and inference test results to compare CAI and non-CAI groups. Rhode Island is conducting a three-way comparison of students being taught by CAI,

Table 3

Instructional Materials

	Bernard Baruch	Brooklyn	Central State	Rhode Island	UCLA	Golden West
Programming language	CWIII	CWII	Basic & Fortan IV	CWIII	Not specified	APL
Course content	English	English	Math	Math & English	Math & English	Math & English
Source of materials	External	Faculty & graduate students	CAI Coordinator & lab assistant	Faculty	External	Faculty

programmed instruction, and conventional classroom instruction. No hard data on results were available yet at any of the institutions surveyed.

In general, student reactions to CAI were described as "good." Only UCLA reported negative student attitudes in response to mandatory scheduling on the terminals, lack of correlation between the CAI materials and their lectures, and abstract questions dealing with reasoning concepts. Other isolated unfavorable reports were related to slow response time of the terminals at Central State, lack of enough materials at Rhode Island, and the inability to "branch" through course segments at Golden West. Aspects of CAI most appreciated by students included practice on math skills and immediate grading, personal attention, and patience.

The respondents offered the following observations concerning their experiences with CAI. Central State, which currently has terminals in separate rooms, would prefer an open classroom with study carrels and recommends that materials be tailored to specific student and class needs, and that borrowed materials must allow for changes to fit specific needs.

UCLA also reported the need to adapt CAI materials to classroom teaching, and pointed out the desirability of both identifying motivated students for participation in CAI and including an orientation program to illustrate the benefits of the program being offered. A final suggestion concerned the advisability of tailoring an entire curriculum to individualized needs, taking into account each student's abilities,

interests, and motivation.

Rhode Island expressed enthusiasm over CAI as a method of teaching, particularly in reference to the self-pacing and immediate feedback capabilities. It recommended the collaboration of two or more institutions in developing and implementing CAI.

Upon rating the issues commonly associated with CAI, three out of four respondents felt local funds for implementation and funds for research and development to be most important. Central State felt the attitudes of the faculty to be most important, and documentation of educational software next in importance.

Although five of the six programs under consideration deal with new students, and generally with the same subject matters--remedial math and English--there is not one instance in which the same materials are being used at more than one school.

The proliferation of CAI languages is partly a consequence of the language incompatibility of the different computer systems and partly related to the predilections of the personnel in charge of programming. While four installations use IBM equipment, one system (IBM 1500) is incompatible with the other three, and requires its own language (Coursewriter II). Of the three installations capable of using the same language, one (Golden West) is writing its materials in APL, rather than in Coursewriter III, which is used by the other two projects. When several programming languages are available on a single system, the language selected is generally the one most familiar to the programming staff, or the one judged by a particular installation

to have merits not necessarily so judged by other installations. At any rate, this problem does not appear close to resolution; attempts are still being made to develop The Instructional Language rather than to perfect those already extant.

Much of the duplication of effort seen in the field of CAI may be accounted for by the programming language problem, but this is by no means the only explanation. Rhode Island found, for example, that the available materials were simply not suitable to the particular needs of its project. UCLA, using existing materials, is finding them unsatisfactory for its needs. While it was not possible to ascertain from the questionnaire responses why existing materials do not transfer well from one project to the next, there are possible solutions to the problem of proliferation of programs and materials.

The development of modular programming may have appreciable value. Under this arrangement each topic to be taught would be written in a single module accessible at all times, i.e., from any other module. This would allow easy exploitation of the second crucial aspect of CAI--flexible course structuring. With modular programming, any installation could present the course in any order deemed desirable. Furthermore, each installation could add its own modules to those of the donor institution. Modifiability is critical if materials are to be exchangeable. Installations must be capable of altering the content and structure of materials borrowed from another school, and this might involve deleting some modules, adding others, or rewriting modules for greater or less depth. If exchanging of course material

is ever to be realized, it is imperative that modularity, flexibility, and modifiability be incorporated into program development.

POSSIBLE SOURCES OF INSTRUCTIONAL MATERIAL

The technical developments in computer hardware far exceed the programming, or software, developments, and computers today offer many more capabilities than are being employed by most users. Because the results of any undertaking in CAI are largely dependent on the instructional material (and *not* on which computer make or model is used), the most care and consideration should be given to the writing and programming phase. And those who should be responsible for the production of such material are the experts in the fields to be taught.

There are certain characteristics associated with CAI which make it somewhat difficult, however, to attract the desired experts. Many subject matter specialists resist learning the programming language and being forced into logical and definite patterns of thinking. This might be overcome by making the fruits greater than the initial labors involved in learning to program, but the high cost of the computer itself makes it difficult to allocate resources substantial enough to attract the desired experts.

One way to solve this dilemma is to postpone the acquisition of the computer until much of the preliminary programming is done. Initially, the major outlays of funds would be used for course development. Skilled course authors would be sought, and if that rare commodity were unavailable, the project would seek imaginative individuals with strong backgrounds in the subject areas.

Another possible solution for program development is seen at Golden West College. With a board of supervisors favoring educational innovation, they have been extraordinarily successful in involving faculty in writing course material. An incentive system involving educational improvements has been incorporated into the faculty evaluation procedure; participation in programs (not necessarily CAI) aimed at improvements in instruction is one basis for faculty review and promotion. Funds have been allocated, as well, to faculty whose proposals for instructional development are accepted. Encouraging faculty involvement in educational research and development through monetary rewards and promotions seems an excellent solution to the problem of acquiring instructors and course materials.

Another means of recruiting "experts" was suggested by Smith (1971). This would involve the students in writing course material, and the following plan represents one possible method of capitalizing on this idea:

The first essential ingredient for such a program would be a skilled practitioner in CAI who would be the liaison between students, faculty, and administrators. He would be responsible for teaching the students instructional programming and elaborating the plan according to the requirements of his particular school.

The second ingredient for such an undertaking would be the "experts" who would write the course material. The main source of course authors would be scholarship and fellowship students, but participation should definitely not be restricted to them because

many of the brightest and most talented students do not have scholarships. Therefore, "volunteer" students would receive academic credit or some other "reward" for their efforts, which might employ one or several media along with or instead of CAI, such as programmed instruction, video tapes, audio tapes, simulations, etc.

All students holding academic scholarships or fellowships would be expected to take a course in CAI the first semester or quarter of their junior year. During the remainder of the year, the student would be expected to produce one hour of course material in his field of interest and to use the media of his choice. During his senior year he would be expected to produce two more hours of instruction. Thus, from each scholarship and fellowship holder the school would be bequeathed with three hours of course material--a substantial legacy from a college's brightest students.

A critical factor in the success of such an undertaking concerns the involvement of the school administrators. They must uphold the requirement that students produce three hours of instructional material during their college career, and make this clear to all applicants for financial aid. While such a stipulation might discourage some applicants, it might also attract creative, industrious, and knowledgeable individuals. Where, but in such a program, could an undergraduate student endow his alma mater and posterity with his own ideas?

For the school with a large student body or with numerous students on scholarships and fellowships, the preceding plan may prove unfeasible. There might be too many students to instruct, and there

would most likely be problems with the allocation of equipment. In such instances (and this might prove more workable for most schools), special scholarships could be offered in each discipline. They would necessarily be attractive enough to invite competition from the most qualified students. Two or three scholarships each year per discipline seems appropriate. Such a limited number would insure strong competition and could promote faculty interest in attempting to secure such scholarships for their departments. The CAI class size would be practicable as well, and would range from between 20 to 30 students.

Equipment is another factor of no small importance in conducting such a program. The choice of equipment and the task of appropriating and allocating funds for it can be monumental.

RECOMMENDATIONS FOR POTENTIAL CAI PROJECTS

The following discussion represents a suggested line of development for prospective CAI projects. Obviously, there are factors (e.g., previous CAI experience, amount of funds available) which would alter the time and sequence of events. We are assuming, however, that the project personnel are relatively new to the field of CAI and that funds are limited.

1. The first year in the life of a project should involve intensive review of available course material, instructional strategies, and the potentials which appear in the literature about CAI but which are seldom realized operationally.

2. The acquisition of the computer should be delayed until all of the relevant factors have been investigated. Some of these

factors include student needs and educational objectives to be met; cost of each system; capabilities of each system (e.g., access time, programming languages, features such as Cathode Ray Tube and image projector); number of students to be accommodated; number of terminals desired and method of separation; existing programs (if any) which meet the student needs and project aims; and programming language required (if using existing programs) or desired (if developing programs).

3. The educational technologist should strive toward equipment and language compatibility and the establishment of sound criteria for program evaluation (Margolin and Misch, 1970). The complications felt to be associated with CAI might partially be resolved through the centralization of organization. This could achieve coordination of efforts, avoiding much of the duplication in the programs produced.

4. The great number of CAI languages (e.g., Coursewriter, BASIC, APL, TUTOR, PILOT) adds confusion to a concept which is already baffling to the layman. Not only must the school administrator worry about which computer will be required, etc., but he must also concern himself with the programming languages of each computer as well as the instructional packages or programs which are available in each language. To the initiated, this task may not seem too difficult, but to one who has only a vague idea about computer technology, the job becomes one of immense proportions.

There is also a programming system incompatibility inherent in most instructional programs (programs developed at School A using

XYZ system will not run on the PQR system maintained at School B without extensive reprogramming). And Atkinson and Wilson (1969) have discussed the lack of a sound theoretical basis for describing levels of learning and achievement.

5. During the process of selecting course materials, contact should be made with institutions involved with CAI [refer to H. A. Lekan, 1971 for a list of 1264 programs cross-referenced by subject matter, central processor, computer language, instructional logic, and source]. Visits should be made to two or three sites to look at their materials and programming strategies. It is important to take particular notice of the weaknesses and strengths of the materials so that the pitfalls may be avoided and the positive aspects duplicated. Performance and program printouts should be scrutinized.

Should suitable materials exist, there is no need to recruit an extensive staff of instructional programmers. If materials are not suitable, course authors can look at instructional strategies and programming techniques which have been developed by others so that they may begin with the experience of their predecessors rather than the more usual line of development--starting at zero.

6. Once the computer and programming language are selected, the programming phase (if necessary) should begin. Course authors should have a thorough knowledge of the content area, instructional strategies to be employed, and the programming language. In the remaining months before the arrival of the computer, course material should be developed (preferably by competent, imaginative people).

Several months before implementation, the course should be put "on line" for testing and the "bugs" ironed out.

7. Procedures should have a monitoring system incorporated in them so that actual field experience will detect the need for and provide means for introducing any necessary modifications.

8. One room with separate study carrels is evidently most desirable when using teletypes. Separate rooms were not satisfactory (Central State), probably due to the physical problems such a layout presents to the proctors assisting students. A single room without carrels was undesirable because of the noise of the teletypes, but is probably suitable for systems with Cathode Ray Tubes, which are relatively quiet.

Four of the institutions under study allowed students free access to the terminals during operating hours. While there were no evaluations of this procedure, it would seem a desirable feature. Students would be able to move at their own pace and be allowed to spend as much time as they wished (assuming, of course, that there is computer time available) reviewing, exploring, or advancing through the materials.

9. The evaluation of results as reflected in student competencies and attitudes toward the process should be routinely secured, analyzed, and considered in appraising the value or utility of the program.

SUMMARY AND IMPLICATIONS

This paper has attempted to delineate some of the potential which CAI holds for education, with particular emphasis on its value for the new student to higher education. The results of a survey of institutions dealing with new students showed that problems of high cost, insufficient experience, and software shortages beset the field of CAI.

While there appears to be general enthusiasm among educational technologists for CAI, it probably will not achieve widespread usage in this decade (Mesthene, 1970). An appeal for more research and development expenditures for program development was made by Margolin and Misch (1970), and a warning against premature evaluation of CAI was given by Stolurow (1969), who wrote, "Probably the major problem with CAI today is that its current level is mistaken for its potential level [p.273]." Mesthene (1970) also has cautioned against premature exploitation and the proliferation of programs whose effectiveness has not been demonstrated.

While CAI appears to hold much promise, much remains to be done in research into the learning process and in course development before its merits can be evaluated. However, its technical feasibility notwithstanding, Lewis's (1970) remarks serve as a worthwhile reminder--that the salient test of CAI in urban education is whether it contributes to narrowing or widening critical gaps between rich and poor, suburb and inner-city, and blacks and whites.

APPENDIX A

CAI Installations Participating in Survey

Bernard Baruch College of the City University of New York
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Brooklyn College of the City University of New York
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Brooklyn, New York 11210
Samuel Moore, Director

Central State University
Special Services Program
Wilberforce, Ohio 45384
Carl Dabney, Director
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Golden West College
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Bernard Luskin, Vice-Chancellor of Educational Development
Monty Ruth, Systems Project Leader

Rhode Island Junior College
Computer Assisted Instruction
199 Promenade Street
Providence, Rhode Island 02908
Charles C. D'Arezzo, Coordinator

University of California, Los Angeles
Academic Advancement Program
Campbell Hall
Los Angeles, California
Albert Dixon, Coordinator

APPENDIX B

PROJECT REPORT QUESTIONNAIRE

In filling out the questionnaire, please answer each question. If there are items which you feel are of a confidential nature, please note by placing a "C" in the margin. Such information will be used only as summary data and will not be identified by school.

Please attach any information you feel would be a useful addition to this survey. Include any proposals, writeups, etc.

If you have any questions, please call Suzanne Sax, 415-642-1967.

PROJECT REPORT

Physical Aspects of CAI Project

Computer Model (e.g., IBM 360, Model 50)_____

CPU Size (e.g., 32K)_____

Average Access or Response Time (if known)_____

Total Number of Terminals_____

Features of Terminal other than Teletype	Number of terminals so equipped
Audio	_____
Image Projector	_____
CRT	_____
Other (please specify)	_____

_____

Location of Terminals

On campus_____ If no, give distance from campus_____

Method of Separation

Separate rooms_____

One room with separate study carrels_____

One room with no separations_____

Other (please specify)_____

Location of Computer

On campus_____ If no, give location_____

Total Cost per Month_____

Cost per Student Hour_____

Any other relevant breakdown of cost_____

Source of Funding	Amount per year	Period of funding
Local	_____	_____
State	_____	_____
Federal	_____	_____

Other (specify)_____

Operational Aspects of CAI Project

Commencement date of project_____

Projected termination date_____

Plans of Expansion? _____ If yes, give details_____

_____

Personnel Involved (list by job title)	Hrs/Wk Employed	Educational Degrees Received	Field of Specialization	Previous CAI Experience	Ethnic Group
Director					
Proctors					

Number of proctors available during full terminal usage_____

Total number of students (expected) to receive CAI treatment per semester____

Average number of students enrolled in CAI courses at any given time_____

Number of students who have completed CAI courses (if your project has been in operation prior to this semester)_____ Number of students who have withdrawn_____

Number of days per week that students have access to terminals_____

Number of hours per day that students have access to terminals_____

Are students scheduled to come in at specific times? _____

Are students free to use the CAI facilities when they wish? _____If yes, are there specific times when students may come in voluntarily? _____ Give details_____

For those students participating in the CAI program, is attendance

Required? _____ Voluntary? _____

Student Information

Total school enrollment_____

Number of first year students_____

Number of first year students classified as educationally disadvantaged_____

Give criteria for classification_____

_____

Number of educationally disadvantaged students receiving CAI per semester

_____

CAI students by ethnic group (give percentages if available)

Black_____ White_____ Brown_____ Red_____ Yellow_____

Criteria for selection of CAI students:

Testing--Give tests and relevant scores_____

Faculty referral_____

Give other information by which students are selected_____

_____

Number of students enrolled in CAI courses by course per semester

Math_____

English_____

Others (specify)_____

Instructional Material

Instructional Language used to program the various courses (e.g., Coursewriter III)

_____

_____

Course Segments (give specific titles or descriptions)	Average Completion Time (Hours)	Number of Lessons	Strategy (Drill, Tutorial, Other--specify)	Multiple Choice	Sentence Completion

Percentage of instruction received by the educationally disadvantaged students via CAI in:

Math_____

English_____

Other(s)--specify_____

Describe other means of instruction (e.g., lecture, individual tutors) received by these students and give percentage for each: _____

_____

_____

Source of CAI instructional material_____

_____

If you are currently doing research using CAI, please answer the following questions:

What hypotheses are you examining? _____

_____

_____

Is there a control group? _____ If yes, give the number and characteristics of the group: _____

_____

By what methods are you evaluating the CAI project? Give testing procedures, intervals between testing, etc. _____

_____

_____

_____

_____

_____

_____

Describe the attitudes of the students toward CAI: _____

_____

_____

Similarly, describe the attitudes of the faculty: _____

_____

To your knowledge, give the extent of faculty awareness of and/or contact with CAI:

_____

What do students like most about CAI? _____

_____

What do they like least? _____

_____

Describe your reactions to the adequacy of your particular computer and terminals:

_____

Describe your reactions to the following:

To the CAI laboratory, facilities, and location: _____

_____

To the instructional material: _____

_____

To CAI as a method of teaching: _____

_____

From your experience with CAI, what information (advice) would you offer to other projects similarly involved? _____

_____

_____

Describe what you consider the optimum conditions for running a CAI laboratory:

_____

_____

_____

Of the following issues[1] commonly associated with CAI, rank them in order of importance (gravity) according to your experience. Add others you think important.

____ Availability of individuals with appropriate competent skills
____ Sufficient local funds for implementation
____ Sufficient funds for research and development
____ Attitudes of faculty
____ Lack of sufficient incentives to stimulate preparation of educational software
____ Poor documentation of educational software
____ Existence of a communications gap between educators and representatives of industry

[1] Molnar, A. R. "Critical Issues in Computer Based Learning," in Educational Technology, August 1971, p. 61.

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Descriptive data was compiled on a sample of 36,581 freshmen from 180 institutions. The sample, composed of "disadvantaged" students, was drawn on the basis of two criteria--parental income less than $6,000 and father's education less than high school. Questionnaires were administered to the students prior to the beginning of their freshman year. Variables examined included demographic variables, educational and occupational aspirations, self-ratings, life objectives and past achievement. Following the freshman year, similar questionnaires were administered which included, as well, items pertaining to their experiences during the year.

Atkinson, R. C. & Wilson, H. A. Computer-assisted instruction: A book of readings. New York: Academic Press, 1969.

The book consists of a collection of papers on CAI written by many of the leaders in the field. Major sections concern: 1) the role of CAI, 2) educational considerations, 3) applications of CAI, and 4) hardware, languages, and economics. The article written by the editors describes the development of CAI over a 10-year period. Also considered are potentials as well as the problems concerning the implementation of CAI.

Baruch, Rhoda. Computer-assisted systems in guidance and education: Report of an invitational conference on the implications for the practice and education of counselors. Washington, D.C.: Office of Education, Bureau of Research, 1969.

Comments from counselors and school administrators who attended a conference on computer counseling systems are presented in this report. Four major systems are represented: The Information System for Vocational Decisions (ISVD), The Educational and Career Exploration System (ECES), The Program for Learning in Accordance with Needs (PLAN), and The Interactive Learning System (ILS). The systems are evaluated by the conference participants and salient issues are discussed (e.g., cost, reliability, general applicability, change and its attendant threat, humanizing vs. depersonalization, and privacy).

Bright, R. L. In J. B. Margolin & M. R. Misch (Eds.), Computers in the classroom. New York: Macmillan, 1970, Pp. v-vii.

The Associate Commissioner for Research of the United States Office of Education has written the Preface to the book, Computers in the Classroom. He discusses the potential use of CAI in education and the obstacles which impede its adoption. While optimistic about the possibilities offered by CAI, particularly in the realm of educating the disadvantaged child, he expresses doubt as to its widespread usage in the decade of the 70's.

Bunderson, C. V. Justifying CAI in mainline instruction. Paper presented at the NSF sponsored conference on computers in the undergraduate curricula, June 1970.

Distinguishing between supplementary and mainline CAI instruction, the former is used largely for drill, practice, and testing, while the latter assumes most or all of the responsibility for the instruction. The cost and production requirements for developing mainline CAI programs are discussed. An individualized instructional environment is presented and illustrated by reference to an example in freshman mathematics.

Carter, C. N. & Walker, M. J. Costs of instructional TV and computer-assisted instruction in public schools. In The schools and the challenge of innovation: Supplementary paper No. 28. New York: Committee for Economic Development, 1969, Pp. 320-341.

Within the framework of a hypothetical school system, an analysis of ITV and CAI is presented. In general, it was concluded that educational technology is expensive, but as development and production expenditures decrease, it may be feasible from the standpoint of cost in the future.

College Entrance Examination Board. A chance to go to college. New York: CEEB, 1971.

As part of the increased efforts to recruit students from minorities and low-income families, this book has been sent to all high schools in the U.S. Basic information is presented such as "deciding where to go to college, applying for admission, money for college," etc. Brief descriptions are given of 829 colleges which have special programs and financial aid for minority and low-family income students.

Glaser, R. The design and programming of instruction. In The schools and the challenge of innovation: Supplementary paper No. 28. New York: Committee for Economic Development, 1969, Pp. 156-215.

Individualization of education is described as a goal which may be attained through programmed instruction (PI). The designing of PI is outlined: defining subject matter competence, determining the characteristics of the learner, arranging the instructional environment to achieve maximum efficiency in learning, and measuring the learning outcomes. The introduction of machines into the instructional process is delineated, and methods for evaluation are given.

Haley, A. The autobiography of Malcolm X. New York: Grove Press Inc., 1964.

The personal story of Malcolm X is told, from his childhood to his adulthood. Rising from a background in which "hustling" and dope played a predominant role, Malcolm X became one of the leaders of the Black Revolution.

Hall, K. A. Computer-assisted instruction: Problems and performance. Phi Delta Kappan, June 1971, 628-631.

A brief description of CAI is presented, and its adaptability to individualized instruction is discussed. The problem of evaluation of CAI programs and the matter of economic feasibility are considered.

Hansen, B. P. The computer in education. The Clearing House, 1970, 45, 195-200.

The computer is discussed with regards to its capabilities for education. Scheduling, the evaluation of educational output, the imposition of systematic thinking about the process and objectives of instruction, and the individualization of the instructional process are areas to which the computer seems particularly applicable.

Hansen, D. N., Dick, W., & Lippert, H. T. Annual progress report. Report No. 7, 1969, Computer-assisted Instruction Center, Florida State University.

CAI projects conducted at Florida State University during the period from January 1, 1968 through December 31, 1968 are described. The studies conducted fall under the general topic headings of Research and Development, Psychology Studies, Computer-Assisted Instruction Methodology, and Graduate Training.

Hess, R. D., et al. The computer as a socializing agent: Some socioaffective outcomes of CAI. Technical Report No. 13, October 1970, Stanford Center for Research and Development in Teaching.

The socializing role of CAI is examined and found to be a positive one in the case of predominantly Mexican-American, junior high school students. General outcomes indicated greater trust and confidence in the computer than in the teacher. The computer was viewed as more objective and as having a vast array of information available to it.

Holtzman, W. H. (Ed.) Computer-assisted instruction, testing, and guidance. New York: Harper & Row, 1970.

This collection of papers was presented at a conference on computers in education. The book includes the following topics: systems design; instructional design; optimizing learning; individually-tailored testing; language processing; Stanford University programs in arithmetic, logic and Russian; simulation of science experiments; complex man-machine systems; and guidance and counseling. The editor's opening statement describes the various aspects of education which may be affected by computers in the years to come, such as administrative services, problem-solving, educational management, and instruction. As a means to individualizing instruction, the following tasks may be assumed in whole or in part by the computer: scheduling, record keeping, measurement, management of learning resources, and guidance services.

Jamison, D., Suppes, P., & Butler, C. Estimate costs of computer-assisted instruction for compensatory education in urban areas. Education Technology, 1970, 10, 49-57.

CAI is discussed in the light of compensatory education in the urban schools. An analysis is made of a current CAI project in New York involving 6,000 children, and results are presented in terms of system cost and utilization, and student achievement. The authors conclude that CAI provides the opportunity for data analysis and confrontation of theories with facts.

Kitano, H. & Miller, D. An assessment of educational opportunity programs in California higher education. Report No. 70-1, 1970, Joint Legislative Committee of Higher Education and Coordinating Council for Higher Education.

The Educational Opportunity Programs in California are examined in terms of recruitment, admissions, special programs such as tutoring and counseling, housing and transportation, and financial assistance. The general finding was that the programs are successful with the vast majority of EOP students making satisfactory progress towards their college degree.

Lewis, H. Computer-assisted instruction and urban education. In J. B. Margolin & M. R. Misch (Eds.), Computers in the classroom. New York: Macmillan, 1970, Pp. 195-203.

The acceptance of CAI is viewed in terms of its socio-political impact. Planners for CAI are encouraged to consider the total spectrum of organized power segments in a city and to involve teachers, parents, students, and community leaders in the decision-making. Such a policy is seen as a means of avoiding "a massive enlargement of human error," a possible outcome of CAI if the basic postulates are wrong (i.e., the making of existing practices, known to widen the gaps between rich and poor, more efficient and effective via CAI).

Margolin, J. B. & Misch, M. R. (Eds.) Computers in the classroom. New York: Macmillan, 1970.

A traveling seminar was conducted which reviewed CAI installations at the following centers: Institute for Mathematical Studies in the Social Sciences; Systems Development Corporation; University of Pittsburgh Learning Research and Development Center; Bolt, Beranek, and Newman, Inc.; Abt Associates, Inc.; The Responsive Environment Corporation Learning Center; and New York Institute of Technology. The participants contributed their opinions of the installations and CAI. Their articles are reviewed by the editors. Changes, likely to accompany the use of computers in education, are discussed, and major issues, such as those having to do with psychological processes, values, and mental health are considered. The various segments involved with education, government, industry, university foundations, and school systems, are urged to combine and integrate efforts for CAI research and development.

Martin, J. H. Self-growth and self-enhancement through technology. Education Technology, 1971, 11, 15-17.

The issue of technology and dehumanization is discussed. While the possibility of depersonalization is granted, it is not seen as a necessary element of technology. Human ideals may be built into any technological system. Criteria cited for learning systems include involvement of the senses, interaction with curriculum, freedom to the act of learning for each individual. Present teaching techniques are seen as catering to middle class backgrounds. Rather, they should provide all children with successful learning, bringing about an "internal euphoria of competence."

Mesthene, E. Computers and the purposes of education. In W. H. Holtzman (Ed.), Computer-assisted instruction, testing, and guidance. New York: Harper & Row, 1970, Pp. 384-392.

While acknowledging that technology holds promise for education, several pitfalls are cited which will hinder its attaining fruition. Included are those of ignoring aspects of learning not understood and concentrating only on aspects which lend themselves to mathematical models, premature exploitation, seductiveness of rigor (i.e., possibility of efficiently proliferating erroneous ideas or teaching techniques), and unconscious reinforcement of values of efficiency and achievement without attending to functions of socialization, preparing for citizenship, and imparting values.

Mitzel, H. E. Computers and adaptive education. American Education, 1970, 6, 23-26.

The computer is viewed as a means to satisfying the goal of adaptive education by providing an environment responsive to individual differences, the traditional classroom is admonished for its lack of human interaction, and for "pitting" students against the teacher and each other. The appeal is made for student evaluation to be based upon mastery criteria.

Muller, L. In J. B. Margolin & M. R. Misch (Eds.), Computers in the classroom. New York: Macmillan, 1970.

The instructional uses of the computer are presented such as problem-solving, simulation, information retrieval, testing, research, and guidance and counseling. Funding and lack of understanding of CAI are seen as obstacles to its proper implementation.

Robinson, L. An orientation to computer technology. In J. B. Margolin & M. R. Misch (Eds.), Computers in the classroom. New York: Macmillan, 1970.

The impact of computers is discussed, and an introduction to computer systems is given. A general description of the means by which data may be entered into and processed by the computer, communication with computers, programming languages, simulation, etc., provides an orientation of how computers are able to assist in the manifold areas in which they are used.

Seltzer, R. A. Computer-assisted instruction--what it can and cannot do. Psychology Today, 1971, 373-377.

The uses of the computer in education are evaluated according to three criteria: whether it poses a unique solution to an important problem in the instructional process, whether it is more efficient and relatively less costly, and whether it is relatively costly with only marginal gains in effectiveness or efficiency. Applications which receive approval are the tutorial mode, simulation and gaming, information retrieval and problem solving. Uses not justified to date (due to cost) include drill and practice and artistic design and composition.

Sherron, R. H. Curriculum research for the disadvantaged adult. Audio Visual Instruction, 1971, 16, 41-42.

The efforts of the Adult Basic Education Program are discussed. Its major goal is to identify, develop and evaluate innovative materials and instructional systems that will accelerate and enhance the learning process for under-educated adults. Programmed instruction and CAI are two systems seen as having much potential for this population.

Silberman, H. F. Applications of computers in education. In R. C. Atkinson & H. A. Wilson (Eds.), Computer-assisted instruction: A book of readings. New York: Academic Press, 1969.

Computer applications in education are presented. Included are the computer as a subject of instruction, the computer as an instructional tool, the computer as a research and development tool, and the computer as a management tool. The problems relating to the use of computers in education are examined. Included are man-machine communication, cost and problems of acceptance.

Stolurow, L. M. Computer-assisted instruction. In The schools and the challenge of innovation: Supplementary paper No. 28. New York: Committee for Economic Development, 1969.

CAI is seen as a means to individualize instruction. Recognizing that much of current CAI is found wanting, the admonition is made to not necessarily judge a system by the material which it displays. Much remains to be demonstrated and learned before CAI should be introduced on a massive scale. Purposes and advantages of CAI are given. Other topics covered include curriculum planning for CAI, man-machine relations and overall costs of CAI.

Suppes, P. Computer technology and the future of education. In R. C. Atkinson & H. A. Wilson (Eds.), Computer-assisted instruction: A book of readings. New York: Academic Press, 1969.

A brief review of the means by which computers may assist in the instructional process is given along with three instructional systems of increasing complexity. First, and most elementary, are drill and practice systems followed by tutorial systems, which present concepts and develop skills. Finally, dialogue systems which allow genuine dialogue are examined, though admittedly at a conceptual rather than operational level. Issues such as depersonalizing the instructional process and excessive standardization are discussed.

Wightman, L. What computers can do now. Paper presented at a meeting of the New England Educational Research Organization, Boston, June 1970.

A description is given of several computer-assisted counseling systems. The systems largely supply occupational or educational information but fundamentally should help students in making better decisions. Educators are urged to become knowledgeable about technological advancements so that they can shape such ventures in the future.